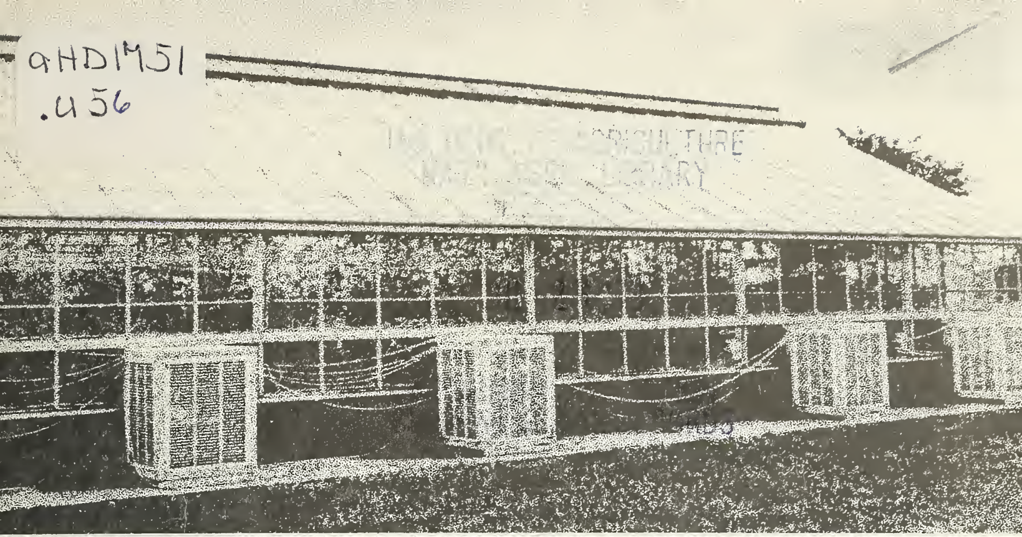
Historic, Archive Document

Do not assume content reflects current scientific knowledge, policies, or practices

aHD1751
.U56



ECONOMICS OF GREENHOUSE TOMATO PRODUCTION IN THE SOUTHEAST

Robert G. McElroy James E. Pallas, Jr. Warren K. Trotter

ECONOMICS, STATISTICS, AND COOPERATIVES SERVICE ESCS-02
U.S. DEPARTMENT OF AGRICULTURE

SUMMARY

Average annual costs of establishing a new small-scale greenhouse tomato operation (8,000 square feet) in the Southeast vary from approximately $11,000 to $20,000, depending on structural design and cropping schedule. Highest entrepreneurial profits are realized with a polyethylene-covered house, growing both fall and spring crops.

Operations of around 8,000 square feet are common in the Southeast, in contrast to much larger operations in the Indiana-Ohio area. The industry is well established in the Northeast, but has only recently developed in the Southeast, where growth has been quite rapid.

Rising fuel costs and lack of marketing experience are the main growers' problems. The wide difference in producer costs between Florida-grown field tomatoes and greenhouse tomatoes limits the market for the greenhouse product. Recent taste tests, however, show consumer preference for greenhouse tomatoes.

Greenhouse tomato growers should establish marketing channels before beginning production. Among the marketing possibilities are direct grower/retailer sales, roadside stands, and route sales. To be successful, the grower must understand the many facets of the business, have managerial skills and patience, and work hard.

March 1978

ECONOMICS OF GREENHOUSE TOMATO PRODUCTION IN THE SOUTHEAST

Robert G. McElroy
James E. Pallas, Jr.
Warren K. Trotter

INTRODUCTION

Annual per capita consumption of fresh tomatoes is exceeded only by that of lettuce and potatoes among fresh vegetable products.[1] Consumption of fresh tomatoes remained fairly constant at around 12 pounds (5.4 kg) between 1965 and 1975, although processed tomato ketchup and tomato sauce consumption increased. This situation, however, reflects only commercial production; the popularity of home gardens would increase the total. In this paper, discussion is limited to fresh tomatoes, although processing-type tomatoes could also be grown in greenhouses.

Interest in greenhouse tomato production in the Southeast has been stimulated by several factors. Aggressive promotion by greenhouse manufacturers is one factor, but claims made by advertisers as to the profitability of a greenhouse operation are frequently exaggerated. For example, a recent ad read -- "$40,000 per year net income . . . with only five greenhouses, less than one acre of land, and nine hours per week per greenhouse" (5).[2] A net income of approximately $40,000 requires a before-tax income of $64,000. Considering current costs and labor requirements as presented later in this report, this would annually require nearly 1.4 acres and over 15,000 labor hours (for just 8 months' production).

Another factor is the interest in alternative enterprises for rural development. The Agricultural

---

[1] Although the tomato is botanically a fruit, it is customarily classed with vegetables in U.S. agriculture.

[2] Underscored numbers in parentheses refer to reference items at the end of the report.

Research Service (ARS), U.S. Department of Agriculture (USDA), at Clemson, S.C., is conducting research in the area of greenhouse-residence combinations. The Rural Development Center at Reidsville, Ga., is working with rural families in growing greenhouse tomatoes for the Savannah market.

The industry appeals to retirees and others looking for a part-time source of income. Since greenhouse tomatoes are typically grown during the winter when other crops require minimal attention, many small farmers see this as an opportunity to more fully utilize their time in an off season.

The greenhouse tomato has been grown in the North Central United States since the beginning of this century (2). Before the development of modern, efficient transportation, it provided the only supply of fresh tomatoes in the area during the late fall and winter. Competition is now more keen from field-grown tomatoes from Florida and Mexico, but the longtime acceptance of the product continues.

In the Southeast, the industry is relatively new but growing. Between 1969 and 1974, the area under production of greenhouse tomatoes in the Southeast (North Carolina, Kentucky, Georgia, Alabama, Mississippi, Tennessee, Virginia, and South Carolina) increased approximately 700 percent (9, 12). North Carolina is the leading southern State with an estimated 1.4 million square feet (130,000 square meters) devoted to the crop (9). Growers in North Carolina use a low cost structure and fuel oil heating.

Rising fuel costs present a major problem to the growers. The lack of marketing experience by growers is another problem. Due to these and other factors, many people who try to commercially produce greenhouse vegetables are not successful. In an attempt to better deal with these problems, growers are asking their State experiment stations and ARS/USDA for help.

Ongoing research at several southeastern centers is concentrating on these problems. Scientists at the ARS Southern Piedmont Conservation Research Center, Watkinsville, Ga., are developing cultural practices to recommend for this area. The University of Georgia is working on a similar project. In Alabama, the Tennessee Valley Authority is experimenting with heating greenhouses using heated waste water from power generating plants. Solar energy conversion for supplemental heat is being tested in Florida, South Carolina, and other States.

This report presents the results of economic research undertaken in cooperation with the Agricultural Research Service. The primary objective of the report is to develop basic economic guidelines for plant science research on greenhouse vegetables, and to provide benchmark data for those involved in the industry. Specifically this includes:

1. Determining the pattern of seasonal variation in market prices for selected southeastern markets as a basis for determining most favorable marketing seasons;

2. Evaluating seasonal changes in the origins and volume of market supplies for selected southeastern markets; and

3. Estimating break-even prices under alternative management systems and for different type structures, and evaluating their sensitivity to wage rates and average yields.

Market Patterns

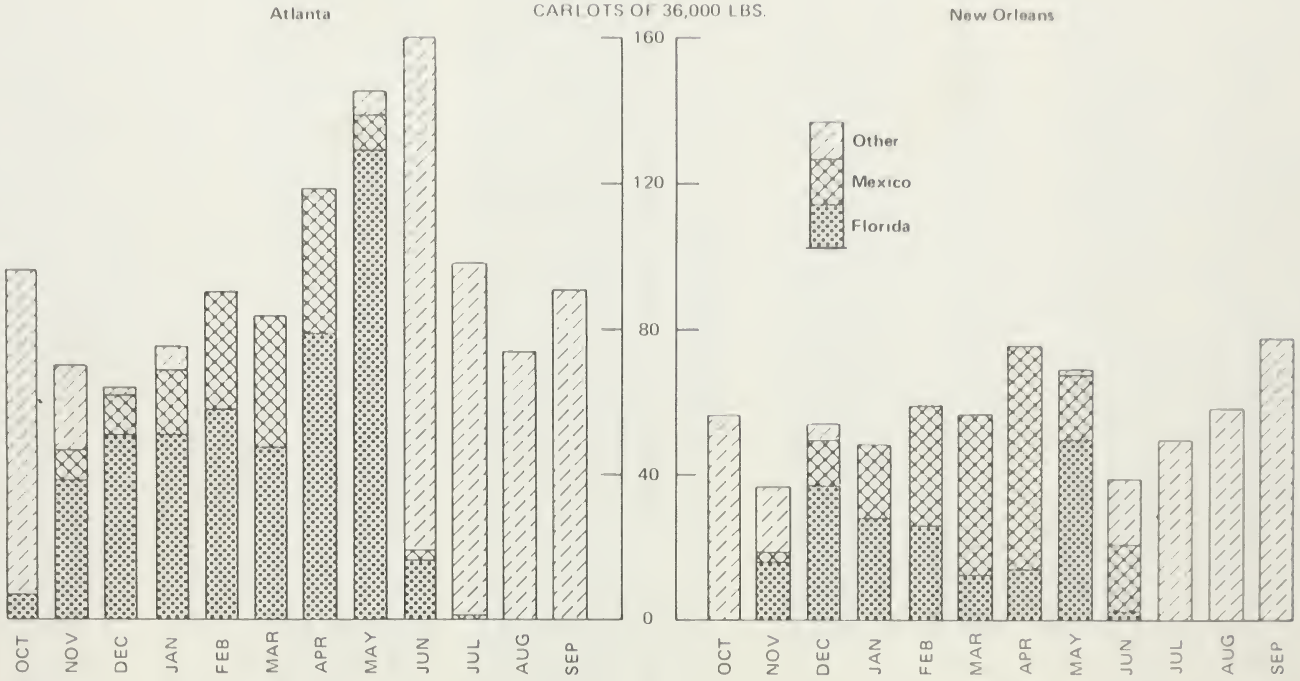
Greenhouse tomatoes grown during the fall, winter, and spring months must compete for a share of the market with the mature green and vine-ripe field-grown tomatoes from Florida, Mexico, and California. During the summer months, locally grown field tomatoes make up the largest share of local markets. The sources of supply of fresh tomatoes in the two major southeastern markets are shown in figure 1.

Average wholesale prices for field-grown tomatoes for these markets are shown in figure 2. Two periods of high prices are evident: a winter high from November through January, and a spring high from April through July. Data are not kept on monthly prices for greenhouse tomatoes in the Southeast, but from figure 2 it can be seen that the greenhouse grower should harvest during these high-price months to better compete in the market.

Taste Panel Tests

Field-grown tomatoes for shipping to distant markets are generally of two classes, depending on their stage of maturity at harvest. These are mature green and vine-ripe which are predominant in Florida and Mexico, respectively. Mature green tomatoes are harvested in the green stage, and

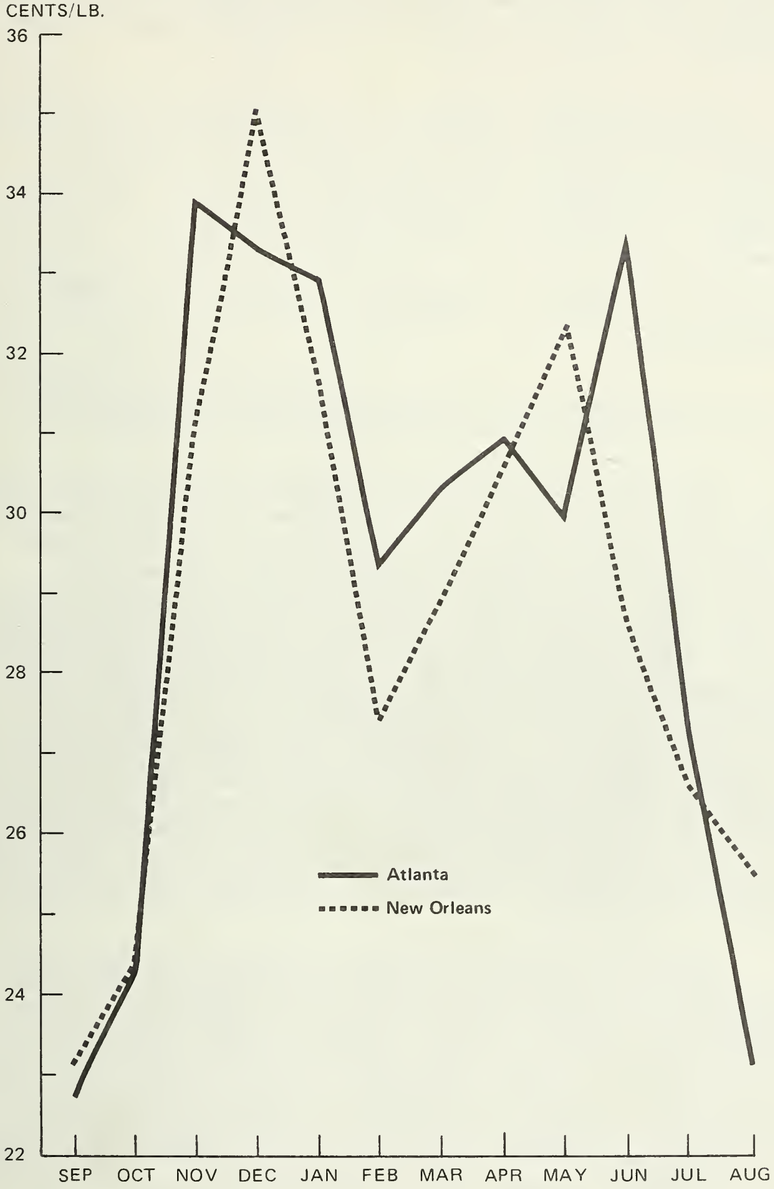
Figure 1 Tomato unloads by point of origin, 1975-76



USDA

NEG. ESCS 2982-78 (1)

Figure 2--Wholesale prices for field grown tomatoes, 1970-76 average



USDA

NEG. ESCS 2983-78 (1)

many are then treated with a hormone (2-Chloroethylphosphonic acid) to hasten ripening. Vine-ripe tomatoes are generally harvested when they just begin to change color. Both classes can withstand the handling and time required to ship long distances. The greenhouse tomato is harvested at almost full ripeness. However, this makes it more perishable, and normally limits the distance it can be shipped to market.

Two tests were conducted by the USDA at the Richard B. Russell Agricultural Research Center, Athens, Ga., to determine if there was a discernible taste difference between field-grown and greenhouse tomatoes. One test ranked 18 varieties of greenhouse tomatoes by characteristics (acidity, sweetness, firmness of flesh, and toughness of skin), and the second ranked five samples (one field-grown and four greenhouse varieties) by taste preference.

In testing the greenhouse and field-grown tomatoes, sample selection and preparation were as follows:

The commercial field-grown samples were obtained from the State Farmers' Market in Atlanta. These had been grown in Florida and Mexico, and shipped green to the market. The samples remained at room temperature to ripen for evaluation. Greenhouse samples were harvested as breakers (beginning to turn red) and kept at 7° C until they were evaluated. On the evaluation day, individual fruits were selected from each variety according to transmittance readings on a Neotec Rephobiospect. A range of 0.15 to 0.30 was selected as the color range that best corresponded to ripeness characteristics as determined subjectively by experimenters. Many factors determine optimum ripeness. Internal color transmittance provides an objective means of selecting fruits of consistent internal color. Panelists ranked the samples 1 = best, to 5 = worst. The results are shown in table 1.

The taste tests indicate that consumers prefer the greenhouse tomatoes over field-grown tomatoes. For the greenhouse tomato to sell, though, it must be visually distinguishable by the consumer. Traditionally, the calyx (stem) has been left on the fruit. More recently, individual stickers identifying the product have been affixed to the tomato, similar to the brand stickers seen on some bananas.

Table 1--Sum of ranks and mean rankings for taste test of greenhouse and commercial tomatoes

Sample (cultivar)	Number in sample	Sum of rank	Mean	Overall rank
Rapid 1/	30	70	2.33	1
Floradel 1/	30	71	2.37	2
Super X 1/	30	72	2.40	3
Tropic 1/	30	99	3.30	4
Walter 2/	30	138	4.60	5

1/ Greenhouse variety.
2/ Commercial field variety.

MANAGEMENT SYSTEMS AND BREAK-EVEN ANALYSIS

Greenhouse tomato production in the Southeast is typically a small enterprise. An average greenhouse operation includes four houses of approximatley 2,000 square feet (185 square meters) each, with newer houses usually covered with polyethylene or fiberglass (6). These houses are principally one of two general designs: quonset shaped using galvanized steel pipe as framing; and ridge and furrow shaped using either wood framing for plastic houses or aluminum for glass houses. The quonset house is the less expensive and easier to set up.

Approximately 500 plants would be found in a typical house of 2,000 square feet. In most areas of the Southeast, peat moss or pine bark mixed with vermiculite is frequently used as a growing medium. Research has shown that two beds of 5 to 6 feet each in width with four rows of plants produce maximum yield (8) and maximize bed space with respect to walkways. Ohio studies (2) recommend 8-11,000 plants per acre (20-27,000 plants per hectare); at 500 plants per house, this averages 10,890 plants per acre.

Cropping schedules usually found are one crop per year (spring) and two crops per year (spring and fall). Fall crops are typically set in the houses in September and harvested from mid-October through December. Spring crops are set in January and harvested from March into July. These two cropping schedules, in addition to the choice of house design, make up management systems from which the grower must plan his operation.

In this study, each of the above management systems was considered and then compared. Profitability of each system was determined by deriving current costs. Input coefficients from ARS research, along with prices from northeast Georgia sources, were used in setting up the budgets.

Costs

Table 2 shows the production costs for an 8,000-square-foot operation. Except for the polyethylene when it is used as a covering, these costs are applicable to all systems. Since the useful life of polyethylene is normally just 1 year, it is considered a production cost, while fiberglass and glass are considered fixed costs.

Table 3 gives the estimated initial capital investment required for the model plastic greenhouse operation. These data are based on a survey of growers in the Tennessee Valley; items directly related to the number of plants (e.g., string and clips) are adjusted to reflect the number of plants used in this report. With the exception of the structure itself, all items are applicable to each system. It should be noted that this schedule depicts a complete, modern operation at new costs.

Assuming an interest rate of 8.5 percent on half of the investment for both capital and production costs, 40 percent tax assessment at 30 mills, 0.5 percent for insurance, and 1 percent for repairs, enterprise budgets for each system and cropping schedule can be derived as shown in table 4.

Estimated Profits and Break-even Points

The costs from table 4 can be used to estimate annual before-tax profits and break-even points. Examples are shown in table 5 and figure 3. In table 5, two cropping schedules are shown along with three wage rates for each of

Table 2--Annual production costs for four 2,000-square-foot plastic greenhouses, June 1977

Inputs	Spring crop only	Spring & fall crops
	Dollars	
Medium: 1/		
Pine bark, vermiculite, and dolomite	807	1,614
Fertilizer (5-10-15 and 0-20-0)	14	27
Covering (4M polyethylene):		
Lining for beds	32	32
Double layer covering	128	128
Labor	70	70
Seedling production	138	245
Insecticide and fungicide	230	460
Fertilizer	319	639
Heating fuel (LP-gas):		
Spring crop	2,722	2,722
Fall crop	---	1,705
Electricity	589	982
Labor @ $2.50/hr.:		
Production	1,900	3,800
Harvest and grading	750	1,500
Total	7,699	13,924

1/ Planting medium life has not been fully determined. The ARS greenhouses in Watkinsville, Ga., still have their original medium (6 crops in 3 years). The annual costs here represent this life of 3 years for the medium. Quantities of the ingredients are based on ARS research, and are similar to those discussed in (8).

Table 3--Capital requirements for four 2,000-square-foot plastic greenhouses, 1977

Item	Initial cost	Useful life	Annual cost
	Dollars	Years	Dollars
Structure (pipe, lumber, etc.)	2,000	20	100
Construction labor	400	20	20
Electrical and plumbing	2,448	20	122
Heating (gas heaters)	4,090	10	409
Water system (pump, well, etc.)	2,403	20	120
Humidity control	956	10	96
Cooling unit	1,348	10	135
Crop growing equipment	387	10	39
Eight fans	1,238	10	124
Four fan jets and center tubes	662	5	132
Motorized shutters for ventilation	1,860	10	186
String and clips for plant support	590	5	118
Bed frame	1,728	10	173
Freight	1,008	10	101
Other	288	10	29
Total	28,406		1,904

Source: (7), plus 44 percent for inflation (from Wholesale Price Index).

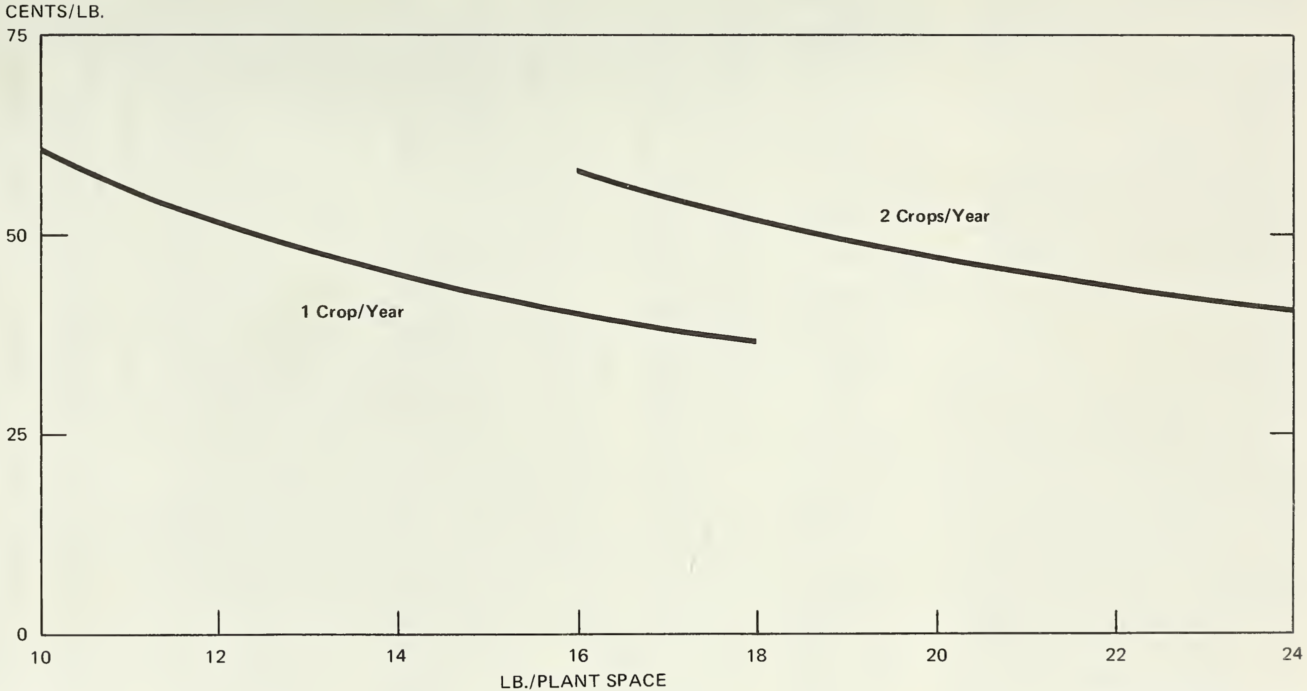
Table 4--Total annual costs for four 2,000-square-foot greenhouses, 1977

Cropping schedule	Quonset, double plastic cover		Quonset fiberglass cover		Ridge & furrow, glass cover	
	Spring	Spring & fall	Spring	Spring & fall	Spring	Spring & fall
			Dollars			
Fixed costs:						
Depreciation	1,904	1,904	2,384	2,384	2,651	2,651
Interest	1,207	1,207	1,403	1,403	1,913	1,913
Taxes	341	341	396	396	540	540
Insurance	142	142	165	165	225	225
Maintenance and repairs	284	284	330	330	450	450
Total	3,878	3,878	4,678	4,678	5,779	5,779
Production costs:						
Production supplies	1,669	3,163	1,508	2,985	1,508	2,985
Heating fuel	2,722	4,427	2,722	4,427	2,722	4,427
Electricity	589	982	589	982	589	982
Labor @ $2.50/hr.	2,720	5,370	2,650	5,300	2,650	5,300
Interest	164	297	159	291	159	291
Total	7,864	14,239	7,628	13,985	7,628	13,985
Total annual costs	11,742	18,117	12,306	18,663	13,407	19,764

Table 5--Estimated annual entrepreneurial profits (dollars)

Price per pound	Spring crop only 13 lbs. (5.9 kg)/plant			Spring and fall crops 21 lbs. (9.5 kg)/plant		
	Plastic	Fiberglass	Glass	Plastic	Fiberglass	Glass
			Wage rate = $2.00/hr			
.40	-1,442	-2,076	-3,177	-1,087	-1,703	-2,804
.45	-142	-776	-1,877	1,013	397	-704
.50	1,158	524	-577	3,113	2,497	1,396
.55	2,458	1,824	723	5,213	4,597	3,496
.60	3,758	3,124	2,023	7,313	6,697	5,596
.65	5,058	4,424	3,323	9,413	8,797	7,696
			Wage rate = $2.50/hr			
.40	-2,082	-2,716	-3,817	-2,267	-2,883	-3,984
.45	-782	-1,416	-2,517	-167	-783	-1,884
.50	518	-116	-1,217	1,933	1,317	216
.55	1,818	1,184	83	4,033	3,417	2,316
.60	3,118	2,484	1,383	6,133	5,517	4,416
.65	4,418	3,784	2,683	8,233	7,617	6,516
			Wage rate = $3.00/hr			
.40	-2,722	-3,356	-4,457	-3,447	-4,063	-5,164
.45	-1,422	-2,056	-3,157	-1,347	-1,963	-3,064
.50	-122	-756	-1,857	753	137	-946
.55	1,178	544	-557	2,853	2,237	1,136
.60	2,478	1,844	743	4,953	4,337	3,236
.65	3,778	3,144	2,043	7,053	6,437	5,336

Figure 3--**Break-even prices and yields for greenhouse tomatoes** (wage rate = $2.50 per hour in plastic house)



USDA

NEG. ESCS 2837-78 (1)

the three structures. The profits are the returns expected at each price. For example, for one crop annually in the plastic house at a wage rate of $2.50 per hour and an average annual yield of 13 pounds per plant, negative profits are shown at prices of $.45 per pound and less, while $.50 per pound are required for positive profits (to the nearest $.05). For two crops per year, the yield per plant is the total weight for both crops (yield per space occupied by one plant). Tomato prices in the two-crop schedule are average prices for both crops (each crop's price weighted by that crop's percentage of its average yield to total annual yield).

It may be of interest to determine at just what price (or wage rate or yield) the operation will break even. In figure 3 (data from table 4), the curves show the minimum price required for various yields so as not to lose money (break-even points).

The methods for determining profits and break-even points are presented in the appendix. Readers can estimate their own equations if their costs differ remarkably from those presented here, following the procedure in the appendix.

ECONOMICS OF OTHER PRODUCING REGIONS

The costs of establishing a new greenhouse tomato operation in the Southeast are high, and producers frequently are unable to recover these costs. This situation appears to be nationwide.

Dhillon and Kirschling (3) expanded a 1969 survey of growers in New Jersey to estimate cost and profit functions. At that time, the industry was very small in the State, but has grown considerably since. The break-even price at that time for a plastic greenhouse with one crop per year, 13 pounds of tomatoes per plant, and wages of $2.50 per hour, was $.48 per pound. Production methods have probably become more efficient in the 8 years since this survey, but costs of fuel and chemicals have nearly doubled, so the break-even price has probably not decreased much, if any.

Ohio was the largest single greenhouse tomato grower in the United States, with 57 percent of the total greenhouse area in 1969, the date of the last agricultural census. Growers have had successful operations there for 50 years. A 1972 survey of Ohio growers is reported by Duvick and

Short (4), where average costs and returns are also presented. Extrapolating these data to the size of greenhouses in the Southeast and to 1977 costs shows production costs of $12,000 for a glass greenhouse with two crops per year. Average depreciation expenses in the report are $750, which would probably explain why Ohio growers are still profiting. This is less than one-third what one would expect, and shows that, in the survey, many growers have already paid off their capital costs. It is unclear as to how many Ohio greenhouse operators would be in business today if they were amortizing establishment costs at today's prices. Ohio showed a 33 percent decrease in the number of producers between 1959 and 1969, perhaps due in part to the high cost of new construction.

The desert Southwest is another area where greenhouse tomato production has shown promise. Capital costs are about the same as in other parts of the country, but heating requirements are less. On the other hand, markets are distant so shipping costs are higher.

FURTHER CONSIDERATIONS

This report presents the economics of greehnouse tomato production in the Southeast. This form of agriculture is a very demanding and expensive operation. A final consideration by anyone concerned with greenhouses, whether growers, extension personnel, or policymakers, should be the existence of sales outlets. With annual grower costs for Florida winter tomatoes averaging between $.14 and $.19 per pound (1), and greenhouse tomatoes averaging over $.40 per pound, promoters and prospective operators should carefully evaluate the market before investing in the business. 3/

Marketing the crop is the area in which most greenhouse operators fail. A thorough understanding of the marketing channels available is a necessity when promoting any form of greenhouse operation. Among the usual options are wholesalers, retailers, roadside or farm stands, and door-to-door routes.

Produce wholesalers complain that in order to handle a product, a steady supply must be available. Individual

---

3/ Figure 2 shows how timing of greenhouse tomato production and sales could help compensate for this cost differential.

greenhouse tomato growers frequently cannot guarantee this; thus, wholesalers may not want to add the item to their inventories. Therefore, growers should visit several wholesalers before assuming any wholesaler will buy the crop.

Small producers might well consider selling direct to retailers. Surveying produce managers in local supermarkets is highly recommended for those choosing this option. Marketing through local stores has the advantages of not requiring distant delivery, and smaller quantities are usually preferred by the store.

Direct selling to the public is a frequently chosen method. In considering this method, sales costs, both in real terms and in lost opportunity time for other endeavors, should be considered.

A combination of sales outlets can also be employed. Whichever is chosen, the additional costs of selling must be considered. These include transportation, time, and any storage required. Liner and Banadyga (6) give a rough figure of 5 cents per pound to estimate the cost of getting the fruit from the grower to the buyer. For an individual who sells his product at the farm and has little or no alternative use for his labor, this estimate is probably high. On the other hand, it is low for someone who only operates a small business and delivers to his customers.

In conclusion, the intensity of greenhouse culture is unlike anything else in crop agriculture and requires great managerial skills, patience, and hard work from the farmer. Opportunities do exist for someone willing to devote the time to establishing marketing channels and managing the many facets of the business.

REFERENCES

1. Brooke, Donald L., Costs and Returns from Vegetable Crops in Florida, Season 1975-76 with Comparisons. Gainesville, Fla.: Dept. of Food and Resource Econ., Univ. of Fla., 1977.

2. Brooks, William M., Growing Greenhouse Tomatoes in Ohio. Coop. Ext. Serv. Publication SB-19. Columbus, Ohio: Ohio State Univ., 1973.

3. Dhillon, P.S., and P.J. Kirschling, Profitability of Tomato Production under Plastic Greenhouses. A.E. 335. New Brunswick, N.J.: Dept. Agr. Econ. and Mktg., Rutgers Univ., 1971.

4. Duvick, Richard D., and W.D. Short, Ohio Greenhouse Tomato Summary, 1972 Crop Year. Econ. and Socio. Occasional Paper No. 215. Columbus, Ohio: Ohio State Univ., 1974.

5. Georgia Farm Bureau Federation, Georgia Farm Bureau News, vol. 36. Macon, Ga.: 1974.

6. Liner, H.L., and A.A. Banadyga, Costs and Returns from Producing Greenhouse Tomatoes in North Carolina. Agr. Ext. Ser. Cir. 558. Raleigh, N.C.: N.C. State Univ., 1974.

7. Ringling, J.C., Jr., and Carl E. Madewell, A Comparison of Two Greenhouse Tomato Production Systems in the Tennessee Valley. Muscle Shoals, Ala.: unpublished TVA Management Intern Rpt., Agr. Resource Develop. Br., TVA, 1973.

8. Spivey, C.D., et al., Growing Tomatoes in a Protective Structure. Coop. Ext. Ser. Leaflet 184. Athens, Ga.: Univ. of Ga., 1974.

9. Tennessee Valley Authority, unpublished survey of State experiment stations regarding greenhouse acreages in the Tennessee Valley, 1975.

10. U.S. Department of Agriculture, Fresh Fruit and Vegetable Unloads in Southern Cities. FVUS-3(1976). Agr. Mktg. Serv., 1977.

11. _________, Fresh Fruit and Vegetable Wholesale Market Prices. Agr. Mktg. Ser., various years.

12. U.S. Department of Commerce, "Crops, Nursery and Greenhouse Products, Forest Products," 1969 Census of Agriculture, vol. II, chap. 6, 1973.

APPENDIX

Derivation of Profit and Break-even Equations

To derive a profit equation, total costs (TC) were broken into three categories:

(1) Fixed costs (FC) include depreciation of the capital goods, interest on capital investment, taxes, insurance, and maintenance and repair. Total fixed costs do not depend on the cropping schedule. (For the plastic greenhouse, total annual fixed costs equal $3,878.)

(2) Growing costs (GC) include production expenses, interest on production expenses, and the value of the labor required to grow the crop. If 760 labor hours are attributable to growing each crop, total annual growing costs for the plastic greenhouse in terms of wage rates equal--

$\$4,980 + 164 + 760w = \$5,144 + 760w$ (for the spring crop), and

$\$8,572 + 297 + 1,520w = \$8,869 + 1,520w$ (for two crops).

(3) Harvesting and packing costs (HPC) vary with the number of plants grown and the yield per plant. They are the total of the harvest labor requirement (in hours), times the hourly wage rate, plus the packing cost. Harvest labor equals the hours required per pound picked, times the number of plants, times the yield per plant; packing cost equals the cost per pound, times the number of plants, times the yield per plant. Assuming 2,000 plants are grown per crop, two hours are required to pick and pack 100 pounds (3), and containers cost $1.50 per 100 pounds of tomatoes, the harvesting and packing cost per crop for each system is:

$$(.02)\ (2000)yw + (.01)\ (2000)y = 20(2w+1)y$$

where w = hourly wage rate in dollars, and

y = annual yield per space occupied by one plant (pounds).

Summing the three components gives the total cost (TC):

$$TC = FC + GC + HPC$$

which in the case of the plastic greenhouse gives (combining terms)

$$TC = \$9{,}022 + 760w + 20(2w+1)y \text{ (for the spring crop), or}$$

$$\$12{,}747 + 1{,}520w + 20(2w+1)y \text{ (for two crops).}$$

Total revenue (TR) is equal to the amount of production in pounds, times the average annual selling price. This may be expressed in terms of variable yields and prices as:

$$TR = 2000yp$$

where y = total annual yield per plant in pounds as before, and

p = average annual selling price. This function assumes only one grade of fruit.

Entrepreneurial profits (Π) are defined as the difference between total revenue and total cost:

$$\Pi = TR - TC$$

or, in simplified form for the data in the model and the plastic greenhouse--

$$\Pi = 20(100p-2w-1)y - 760w - \$9{,}022 \text{ (for the spring crop), or}$$

$$20(100p-2w-1)y - 1{,}520w - \$12{,}747 \text{ (for two crops).}$$

The break-even point is computed by setting the profit function equal to zero and solving for the desired variable. For example, the break-even price for the plastic greenhouse and one crop per year is \$0.48 per pound, and is based on the equation:

$$p = \frac{1}{y}(.38w+4.511) + .02w + .01$$

where y = yield per plant (13 lbs.)

w = wage per hour ($2.50), and

p = average annual price per pound.

The same equation can be manipulated to show break-even yields and/or wage rates. However, care must be exercised when interpreting results. For example, the break-even prices in figure 3 are the average annual prices which, in the case of both a fall and spring crop, would be the average of the fall price and the spring price weighted by the respective yields.

UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D.C. 20250

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF
AGRICULTURE
AGR 101
THIRD CLASS

U.S.MAIL